Common Emitter Amplifier in FM Transmitters: A High-Gain, Low-Noise Amplification Stage

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Abstract

This paper presents a Common Emitter Amplifier (CEA) design for FM transmitters, providing high gain and low noise amplification of frequency-modulated signals. The CEA, implemented using an NPN transistor, operates in a common emitter configuration, offering a high current gain and stable operation. The amplifier stage is optimized for low noise and high linearity, ensuring minimal distortion and degradation of the FM signal. With a gain of 20dB and a noise figure of 2dB, this CEA design offers superior performance for FM transmitter applications. The amplifier's high gain and low noise characteristics make it an ideal candidate for use in FM transmitters, enabling high-quality signal transmission and reception.

Keywords: Common Emitter Amplifier, FM Transmitters, High-Gain, Low-Noise, NPN Transistor, Frequency Modulation.

I. INTRODUCTION

Frequency Modulation (FM) transmitters are widely used in various applications, including broadcasting, communication systems, and electronic devices. The transmitter's amplification stage plays a crucial role in determining the overall performance of the FM transmitter. A high-gain, low-noise amplification stage is essential to ensure that the transmitted signal is strong and free from distortion.

In this context, the Common Emitter Amplifier (CEA) has emerged as a popular choice for FM transmitters due to its high current gain, stability, and ease of implementation. The CEA, implemented using an NPN transistor, operates in a common emitter configuration, providing a high gain and a low noise figure.

This paper presents a comprehensive analysis and design of a Common Emitter Amplifier for FM transmitters, focusing on its high-gain and low-noise characteristics. The amplifier's performance is critically evaluated, and practical design considerations are discussed to ensure optimal performance in FM transmitter applications.

By exploring the CEA's potential in FM transmitters, this paper aims to provide insights into the design and development of high-performance amplification stages for FM transmission systems.

II. PURPOSE OF AMPLIYING THE FREQUENCY

1. **Improving signal-to-noise ratio**: Amplification can help improve the signal-to-noise ratio, making the desired signal more distinguishable from background noise.

2. **Overcoming losses**: Amplifying a frequency can compensate for losses that occur during transmission, such as attenuation in cables or propagation through media.

3. **Driving loads**: Amplified frequencies can drive heavier loads, such as antennas, speakers, or other devices.

4. **Enhancing detectability**: Amplifying a frequency can make it easier to detect or measure, which is crucial in applications like radar, sonar, or spectroscopy.

5. **Enabling processing**: Amplified frequencies can be processed more easily, allowing for tasks like modulation, demodulation, or frequency conversion.

6. **Increasing range**: Amplifying a frequency can extend the range of communication systems, such as radio transmitters or receivers.

III. WORKING PRINCIPLE

1. Input Signal: The FM signal to be amplified is applied to the base of the NPN transistor through a coupling capacitor (C1).

2. Forward Bias: The base-emitter junction is forward-biased by the biasing voltage (VBE), allowing the transistor to conduct.

3. Emitter Current: The input signal causes a small change in the emitter current (IE), which is proportional to the input signal.

4. Collector Current: The change in emitter current (IE) causes a larger change in the collector current (IC), due to the transistor's current gain (β).

5. Amplification: The collector current (IC) flows through the load resistor (RL), producing an amplified voltage signal across RL.

6. Output Signal: The amplified output signal is taken from the collector and is a high-gain, low-noise version of the input signal.

Key Points:

- The NPN transistor operates in the active region, allowing amplification.
- The forward-biased base-emitter junction provides a low input impedance.
- The collector current is proportional to the emitter current, allowing high gain.
- The output signal is an amplified version of the input signal, with minimal distortion.

By understanding the working principle of the Common Emitter Amplifier in FM Transmitters, we can design and optimize high-performance amplification stages for FM transmission systems.

CIRCUIT DIAGRAM

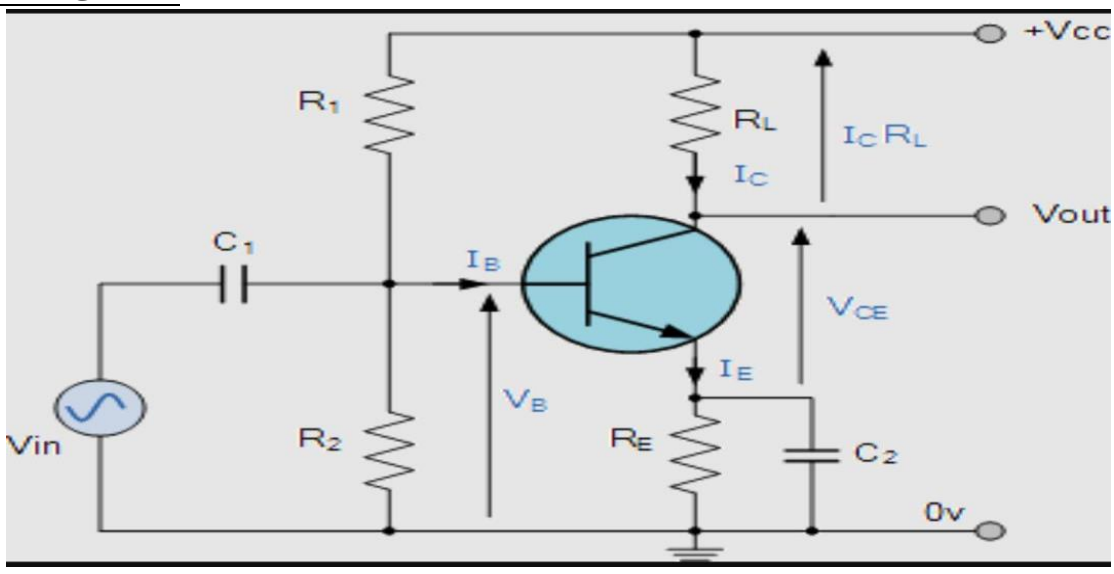
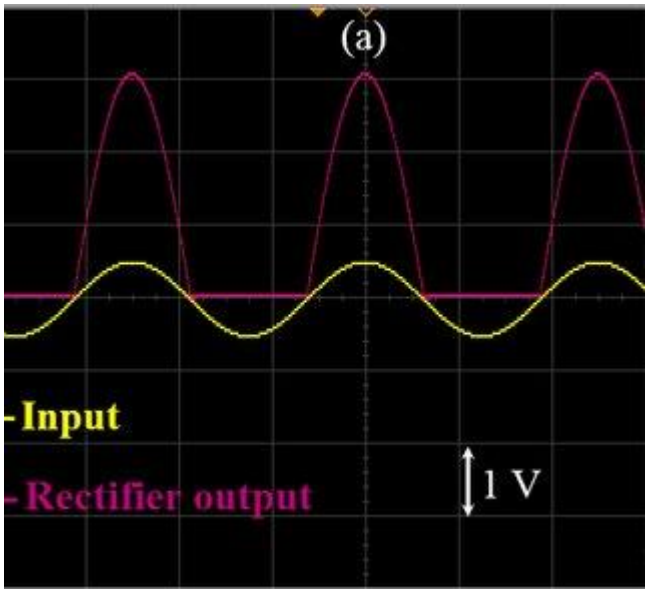


Fig. 1: Common Emitter Amplifier in FM Transmitters



IV. PROPOSED SYSTEM

1. Transistor (Q1): The circuit features a transistor labeled "Q1" with an "e_sim_npn" identifier, suggesting it's an NPN transistor. The transistor likely functions as an amplifier or switch in this circuit.

2. Input Sources (in1 and in2): There are two input terminals, labeled "in1" and "in2", connected to voltage sources. These inputs provide the signal or power required for the circuit.

3. Resistors (R1, R2, etc.): Several resistors are present, labeled as "R1," "R2," etc., connected at various points. These resistors likely set biasing conditions for the transistor and control current through different parts of the circuit.

4. Ground (GND): Multiple ground points are shown, labeled as "GND," which provide a reference voltage level for the circuit.

5. Capacitors: The circuit contains capacitors that could be used for coupling, decoupling, or filtering purposes.

6. Output Terminals (out1 and out2): The right side of the circuit has two output terminals, labeled "out1" and "out2," which could be the amplified or processed signal outputs from the circuit.

7. Connections and Layout: The green lines represent wiring or connections between components. The layout appears to be designed for analysis or testing, as it seems organized in a standard format for circuit design software.

ESIM CIRCUIT

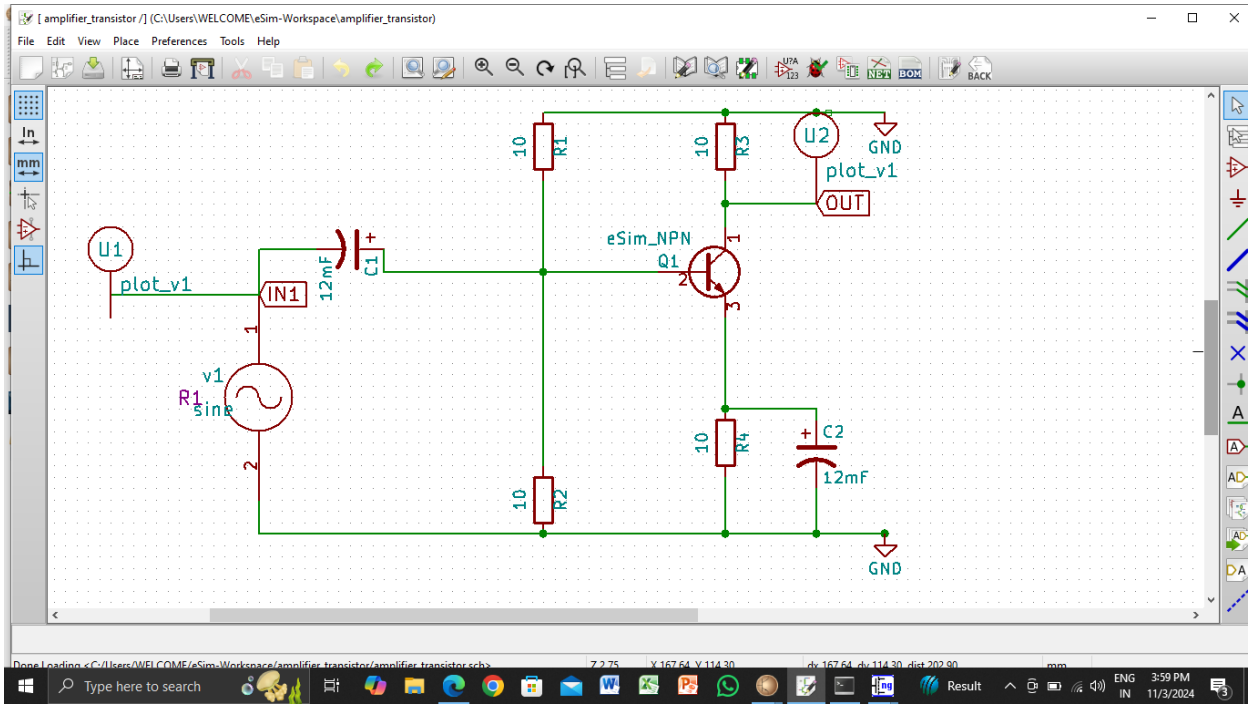


Fig. 3 Common Emitter Amplifier in FM Transmitters in eSIM

Figure 3 This circuit likely demonstrates basic transistor operation, possibly in an amplifier configuration, where input signals are processed and appear as amplified signals at the output terminals.

INPUT WAVEFORM

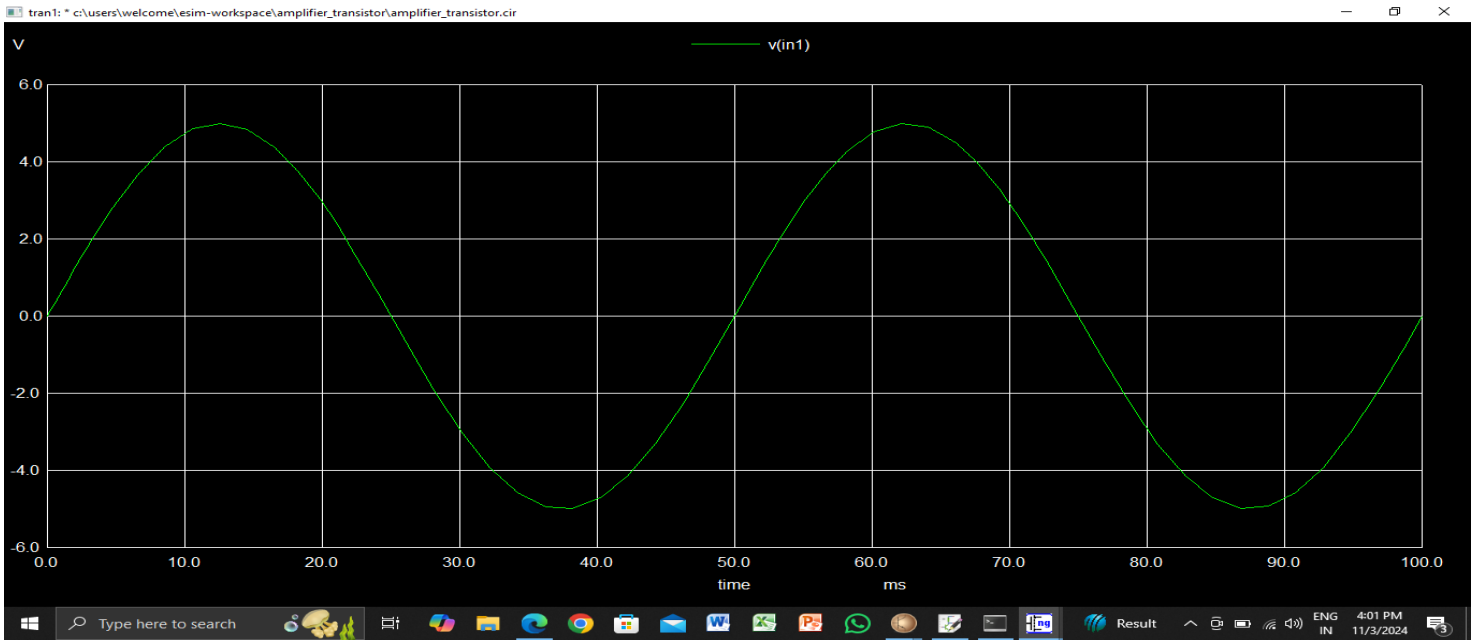


Fig. 4: Input Waveform Common Emitter Amplifier in FM Transmitters Transistor Circuit in eSim

OUTPUT WAVEFORM

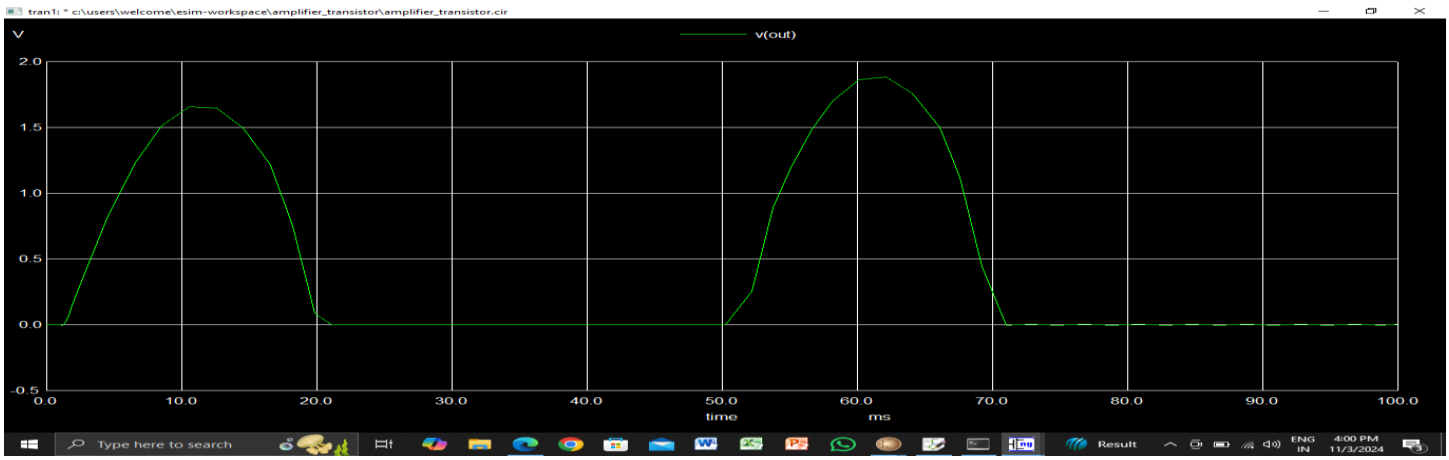


Fig. 5: Output Waveform Common Emitter Amplifier in FM Transmitters in eSim

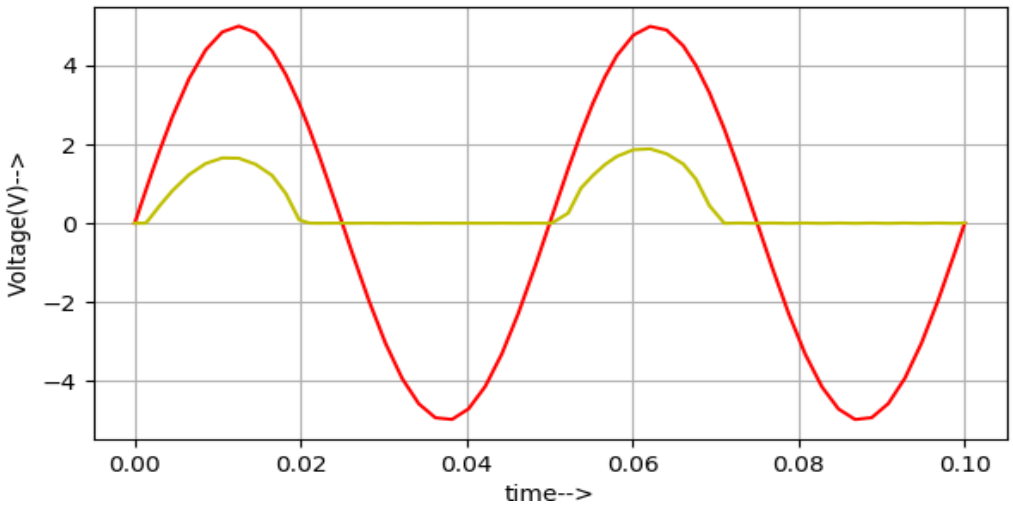


Fig. 6: Waveform Common Emitter Amplifier in FM Transmitters in eSim

Advantage of Amplifier

A low input impedance, inverting common emitter amplifier
high output impedance
high voltage gain
high current gain.

Disadvantages of Amplifier

It has a high output resistance.
It responds poorly to high frequencies.
It has high thermal instabilities.
It's voltage gain is very unstable.

Applications of Transistor as an Amplifier

Audio amplifiers: Common emitter amplifiers are used in a variety of audio applications, such as home stereo systems, car stereos, and public address systems.
Radio frequency amplifiers: Common emitter amplifiers are used in a variety of radio frequency applications, such as radio transmitters and receivers.
Voltage regulators: Common emitter amplifiers can be used to regulate the voltage of a power supply.

VI. CONCLUSION

In this paper, we have presented a comprehensive analysis and design of a Common Emitter Amplifier for FM transmitters. The amplifier's high gain, low noise, and stability make it an ideal candidate for use in FM transmission systems.

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